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Design of Series Feed Microstrip Patch Antenna Array using HFSS Simulator

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***Abstract-* In this paper series feed Micro strip Patch Antenna Array are designed and analyzed for WLAN application, which operating at S-band frequency Range of 2.4 GHz. Antenna arrays are used to achieve higher gain. Larger the number of antenna elements, better the gain of antenna array would be achieved. In this paper feeding element and matching line is used to design the 4 X 1 micro strip patch antenna array. Micro strip line feed and matching line are used to design series Micro strip patch antenna array. The measured radiation pattern and Return loss of 4X1 elements antenna array are presented. An-soft HFSS simulator is used.**

Index Terms: Micro strip antenna array

I. Introduction

Antennas are the basic component of any electric system and are connecting links between the transmitter and receiver. Thus antennas play very important role in finding the characteristics of the system in which antenna are employed. Antennas are employed in different systems in the different forms [1]. The antennas are used simply to radiate electromagnetic energy in an omnidirectional or finally in some systems for point to point communication purposes in which increased gain and reduced wave interference are required. In spacecraft or aircraft applications, where size, weight, cost, performance, ease of installation, low profile antennas are required. In order to meet these specifications Micro strip Patch antennas are used [2].

An Antenna is an electrical device which converts electric current into radio waves and vice-versa. It is usually used with radio transmitter or radio receiver. In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna terminals and the antenna radiates the energy from the current as electromagnetic wave. In reception, antenna intercepts some of the power of electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified. An antenna can be used for both transmitting and receiving. An antenna is a device that converts a signal transmitted from a source to a transmission line into electromagnetic waves and that is used to broadcast into free space and vice versa. An antenna is concentrating the radiation energy in some directions and to suppress it in the other directions at certain frequencies. An antenna must me tuned to the same frequency band of the radio system to which it is connected; otherwise the reception and the transmission will be impaired. A good antenna design can improve overall performance of the system which is depending on the physical size [3].

Micro strip patch antenna is popular for low profile applications at frequencies above 100 MHz. Micro strips Antenna is used in wireless communications, satellite communications, and radar, due to low profile, low weight, and low cost, easy fabrication into arrays [4]. The major disadvantage of micro strip antennas are their inefficiency and very narrow frequency bandwidth which is typically only a fraction of percent or few percent, limited power capacity and tolerance problem. To overcome the bandwidth limitation, number of antenna elements or feeding matching networks may be employed in order to satisfy the bandwidth requirement for the particular application. Antennas play an important role in today's wireless communication. Without the use of antenna, signals are not able to be transmitted out or received.

While designing an antenna, we must consider the important characteristics of the antenna which are defined as:

- Radiation Pattern
- Radiation Intensity
- Directive gain or Directivity
- Efficiency
- Operating frequencies
- Power Gain

In this paper, a 4 element high gain micro strip antenna array by feeding network at S-band is presented. The simulation of the proposed antenna has been carried out using Ansoft HFSS software.

II. Microstrip Patch Antenna Design

A. 1antenna Array Architecture

A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common micro strip antenna shapes are square, rect-angular, circular and elliptical, but generally rectangular and circular are most commonly used. Some patch antennas do not use a dielectric substrate and instead made of a metal patch mounted above a ground plane using dielectric spac-ers; the resulting structure is less rugged but has a wider bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be shaped to con

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form to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices. The radiation pattern of a single element is relatively wide and each element provides low values of directivity (gain). In many applications, especially for point to point communication system it is necessary to design antennas with very directive characteristic (high gain) to meet the demands of long distance communication.

Antenna is composed of four parts which are air, two radiation substrates and feed substrates. To be compatible with the feed excitation of the antenna array elements, a Centre coupled edge feed and square patch have been chosen. The Micro strip square patches (29mmX29mm) are etched on the top of the radiation substrates separated by air (0.1 free space wavelengths at the Centre frequency) and Micro strip feed line (16.994mmX18.381mm) are etched on the both side of the feed substrate. The Centre of patches and slots are situated in a line and feed line is positioned at the Centre of the slot for maximum coupling.

A thicker substrates result in wider bandwidth, but less coupling for a given aperture size. The dielectric constant 4.2mm and the thickness of the substrate 1.6mm have been chosen as the material for the substrate for both the patches.

B. Micro Strip Line Feed

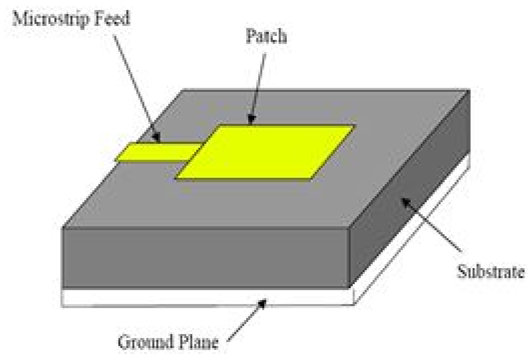
In this type of feed technique, a conducting strip is connected directly to the edge of the micro strip patch as shown in figure (a). The conducting strip is smaller in width as compared to the patch and this kind of the feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure.

The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence, this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However, as the thickness of dielectric substrate being used increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarization radiation. This method of feeding is very widely used.

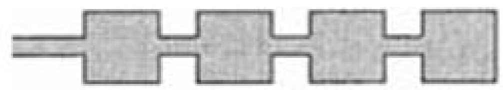
The series feed as shown in figure (b) usually consists of a continuous transmission line from which small proportion of energy are progressively coupled into the individual element disposed along the line. The series feed constitutes a traveling wave array if the feed line is terminated in a matched load.

In this paper the matching line with square patch is being discussed for the series feed micro strip patch antenna array design.

In this paper matching line, square patch and line feed is used in designing series feed Micro strip patch antenna array. A 4x1 sub-array of individual patch antennas of size 29mm x 29mm is designed in this section. The size of the individual element was chosen for the successful operation of the sub-array at the operating frequency of 2.4GHz.



(a) Micro strip feed



(b) Series feed

Figure 1 Type of feed network in Micro strip antenna array

It is easy to achieve the required input impedance because of its simple and symmetric structure.

The effects of the feed network are important in high gain Micro strip antenna array with large number of radiating elements and complicated feed network.

III. Design Procedure of 4x1 Microstrip Patch Antenna Array

In this proposed paper a 4X1 array of individual Micro strip patch antenna is designed to achieve higher gain, better bandwidth, and input impedance of the antenna array. Because single antenna is not enough to achieve high bandwidth it has limited bandwidth. The square patch is chosen because it simplifies and analysis and performance prediction. This antenna has been designed to operate at 2.4 GHz with input impedance of 50 Ω, using FR4 (ε = 4.2) and height (h=1.6mm). The design starts with the simple square patch Micro strip antenna with line feed. Then, the Micro strip antenna is simulated using the Ansoft HFSS Software. After the simulation, the Micro strip antenna is fabricated using FR4, with dielectric constant (ε = 4.2) and height of 1.6 mm. Finally the Micro strip antenna is measured using the network analyzer and the measured values are compared with the simulated values. Figure 2 shows four element square patch micro strip antenna. In this, we have design four square patch antenna array.

Figure 3 shows a patch with micro strip line feed from the side of the patch. This method of feeding is very widely used because it is very simple to design and analyze and very easy to manufacture.

IV. Simulation Results

The parameters which have been measured are Return loss and Radiation pattern. The first measurement that was performed is Return Loss. It ensures that antenna exactly operate at 2.4GHz.

From the figure 4 it is found that the S11 frequency at

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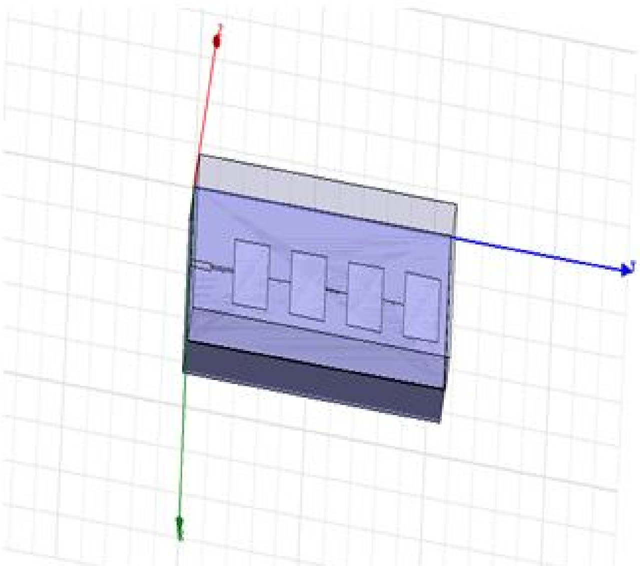
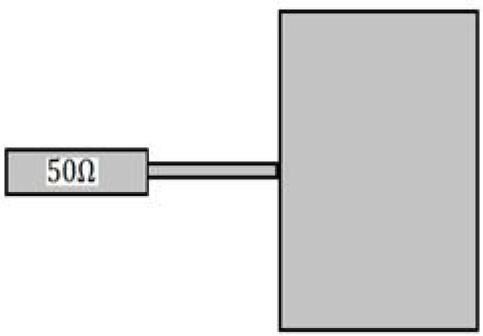


Figure 2: four element square patch micro strip antenna



(a)

Figure 3: Shows a patch with micro strip line feed from the side of the patch

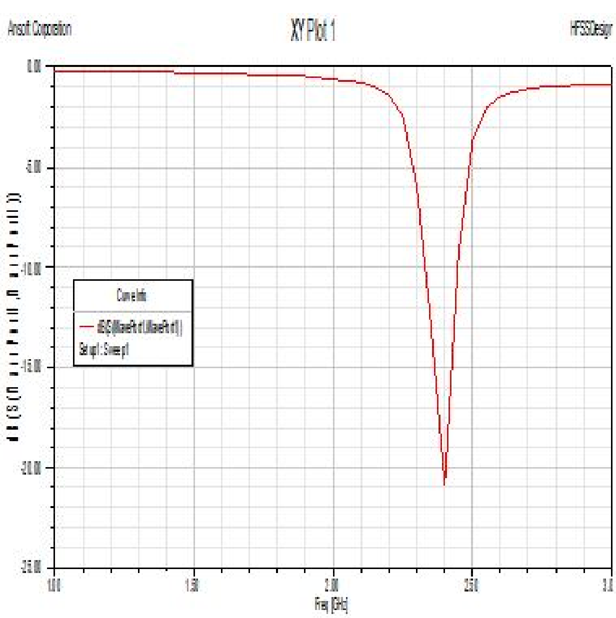


Figure 4: Measured Return loss of 4x1 Micro strip patch Antenna Array

2.4GHz gives return loss of -21dB. The bandwidth for simulation and measurement are 16% and 18%.

In the figure 5, 3D radiation pattern of patch antenna is measured. There are the two types of radiation pattern H-Plane and E-plane Radiation Pattern. H-Plane will have a circular and omnidirectional pattern means its perfect circle but E-Plane is not uniform. The maximum gain observed in 3D radiation pattern is 5db.

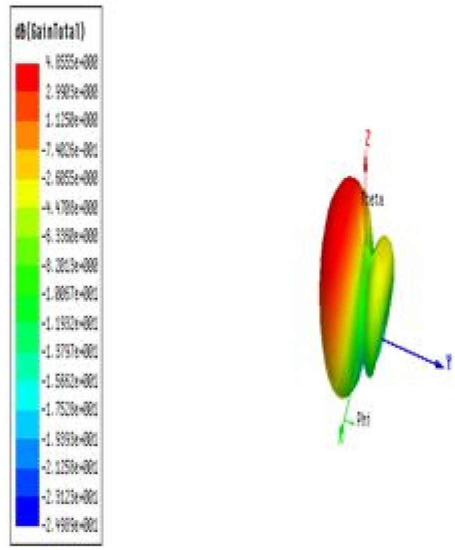


Figure 5: Measured patch 3D Radiation Pattern

V. Conclusion

In this paper, 4 elements series Micro strip patch antenna array by micro strip line feed stacked at S-band are presented. They achieve higher gain and better bandwidth with practical technology and theoretical analysis. The measured gain in this antenna is about 5.0dB and the return loss is -21dB. Numerical calculation clarified that the Radiation coefficient of radiating elements was varied widely. In this paper S-band Micro strip patch antenna arrays may be employed in communication links, seekers, and detection arrays. From the above result it is noticed that the increase in the thickness of substrate had increased the impedance bandwidth of the antenna and also decreased VSWR values.

Table I. Measured Antenna Parameters

Antenna Parameters	Calculated Value
Gain	5 dB
Return loss	-21dB

VI. Test and Measurement

In this paper, series feed micro strip antenna array is designed using An-soft HFSS simulator. From the table-1 it can be observed that the measured gain in this antenna is about 5.0 dB and the return loss is -21dB.They achieve higher gain and better bandwidth with practical technology and theoretical analysis. Numerical calculation clarified that the Radiation coefficient of radiating elements was varied widely. In this paper S-band Micro strip patch antenna arrays.

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References

[1] Constantine A. Balanis (2005). Antenna Theory-Analysis and Design. 3rd Edition, john Wiley & sons. Inc. USA.

[2] Pozar D.M. "Micro strip antennas, "Proc. IEEE, Vol. 80, 1992.

[3] Amin Rida and Manos Tentzeris, " Design of Low Cost Micro strip Antenna Arrays for mm-Wave Applications", Antennas and Propagation 2011 IEEE International Symposium pp. 2071-2073.

[4] K.C HUANG and D .J. EDWARDS, millimeter wave antennas for gigabit wireless communication, WILEY, 2008

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